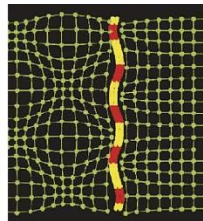
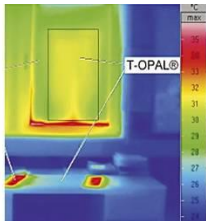

Energy Renovations in Germany – What Finland can learn

Heike Erhorn-Kluttig

Fraunhofer Institute for Building Physics

Rakennusten energiaseminaari
Finlandia-talossa

08/10/15



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The Fraunhofer-Gesellschaft

- 66 institutes and independent research units
- more than 22,000 employees

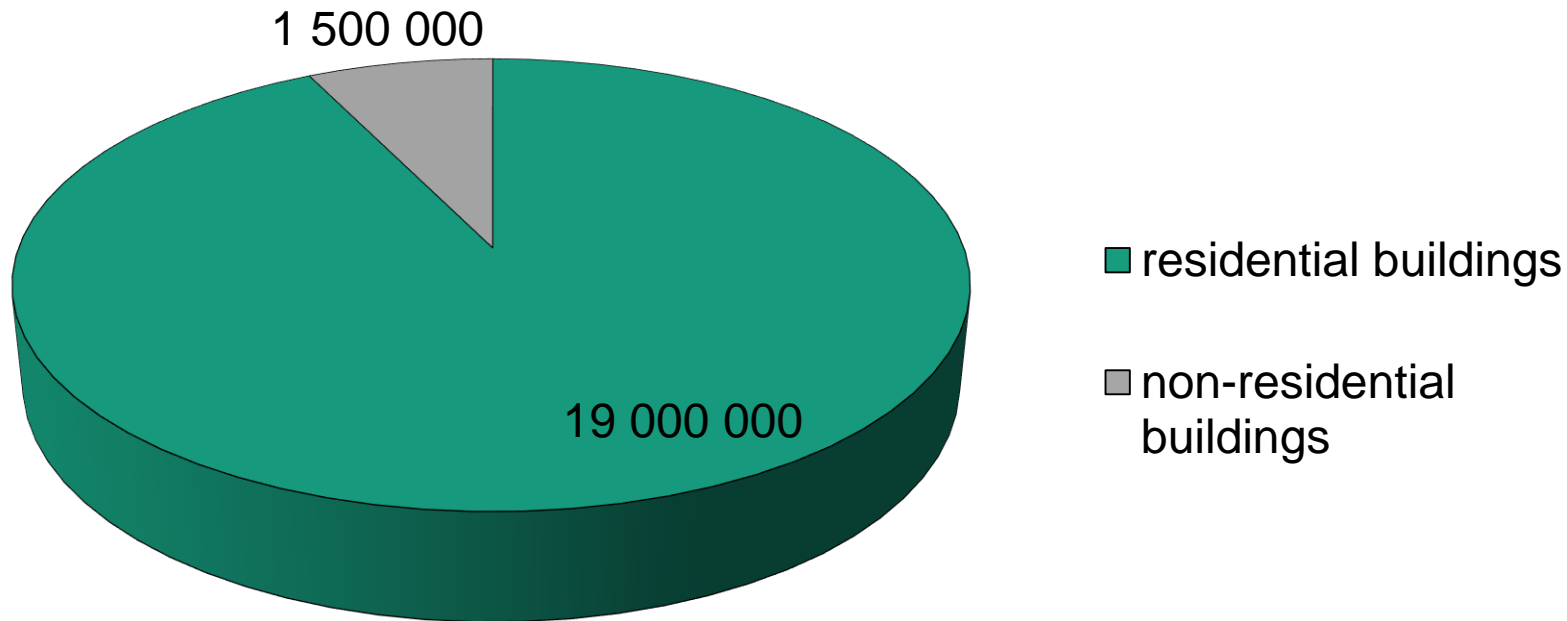
Fraunhofer Institute for Building Physics

- > 430 employees
- budget: 29.3 million Euro (2013)
- Core competences:
 - Acoustics, noise control
 - **Energy efficiency**, building systems
 - Lighting technology, indoor environment
 - Hygrothermics
 - Durability, preventive conservation
 - Chemistry, microbiology, hygiene
 - Life cycle engineering



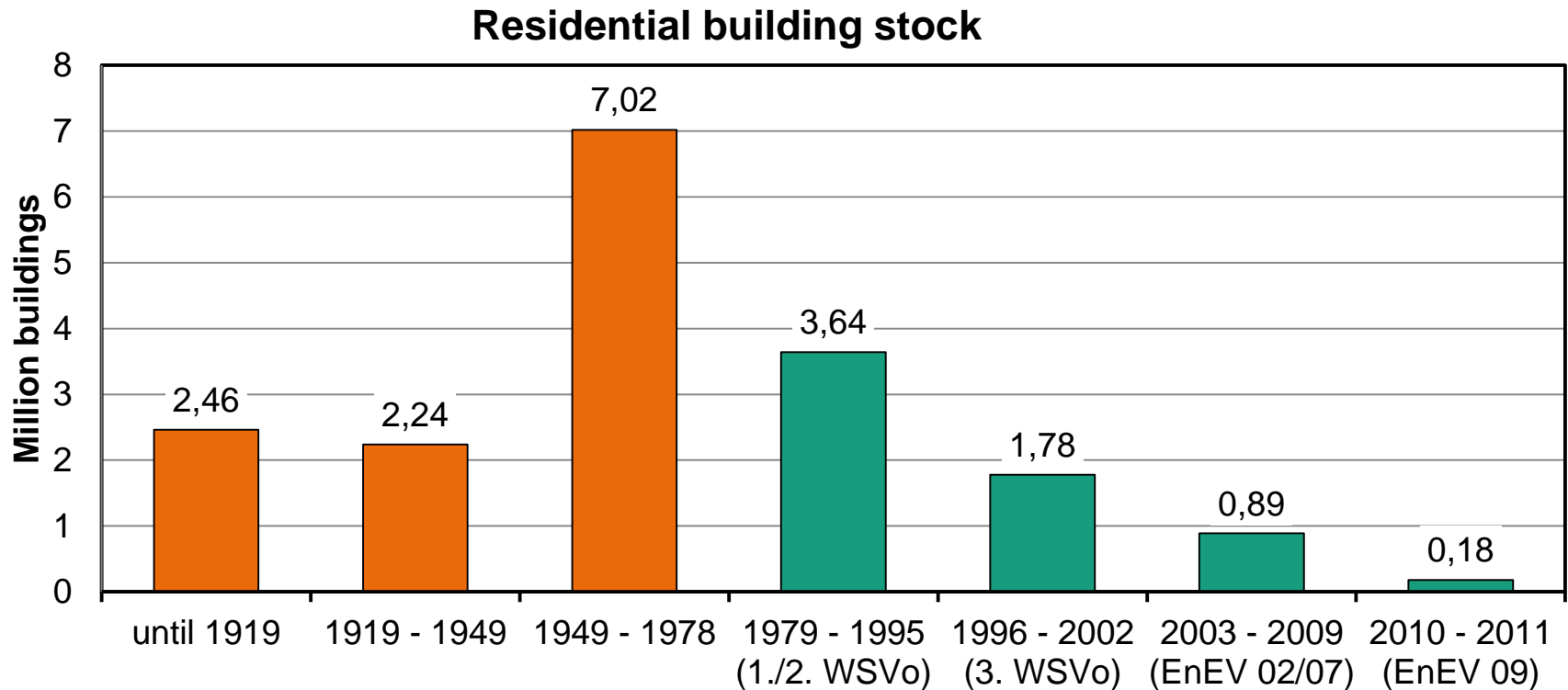
Statistics Germany

Building stock



- **Good statistical data on residential buildings:** types, age, status, energy supply, ownership
- **Limited statistical data on non-residential buildings:** further analyses needed
- Energy efficiency strategy for buildings of the Federal Ministry of Economy is concentrating on residential buildings

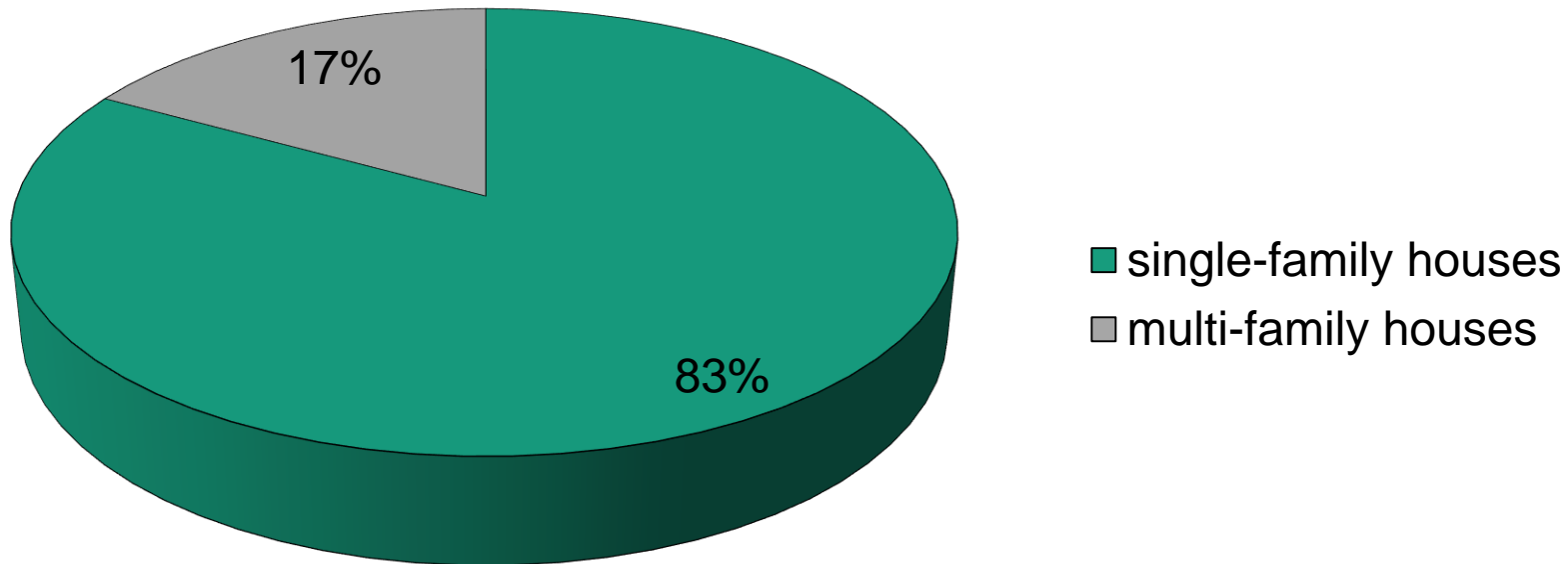
Statistics Germany



- **11.72 million houses** have been built **with no specific U-value requirements** in place (Basic U-values for mould and moisture prevention, some renovations have been made in between)

Statistics Germany

Residential buildings



- Single-family houses: 1 or 2 residential units
- Multi-family houses contain 53% of the residential units
- Building sector corresponds to nearly 40% of the total final energy use in Germany

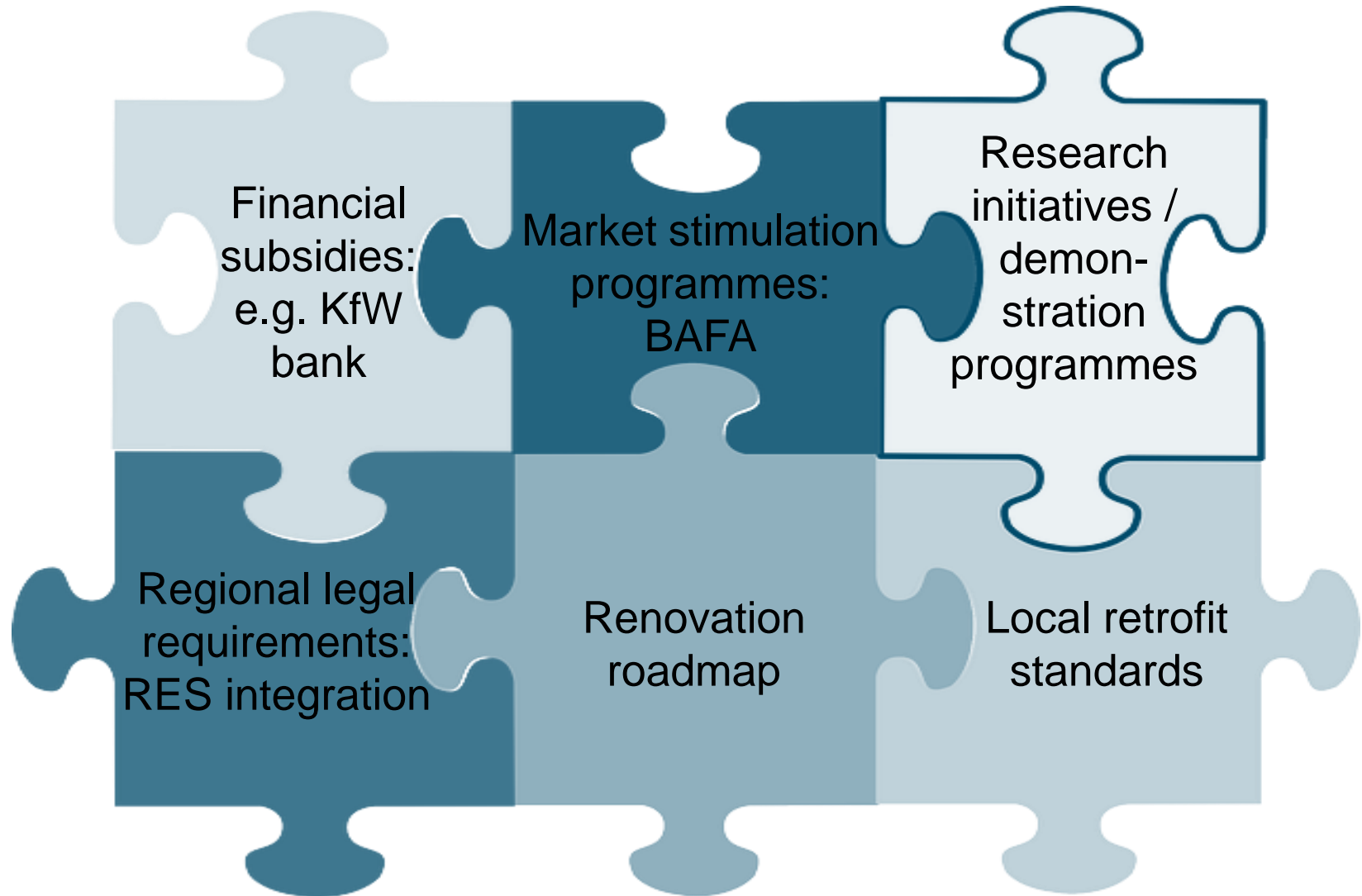
Energy Renovation in Germany: Legal Requirements

- Renovation has to stay **voluntary**
- Specific **legal retrofitting obligations** (Nachrüstverpflichtung):
 - Replacement of heating boilers installed before 1985 (older than 30 years)
 - Insulation of distribution pipes in unheated areas
 - Insulation of the ceiling to the attic
-> should be profitable very quickly
- **Maximum U-values** for the installation, replacement and renewal of building components (major renovations, EPBD):
 - Wall: $U_{\max} = 0.35 \text{ W/m}^2\text{K}$
 - Windows: $U_{\max} = 1.3 \text{ W/m}^2\text{K}$
 - Pitched roof: $U_{\max} = 0.24 \text{ W/m}^2\text{K}$
 - Flat roof: $U_{\max} = 0.20 \text{ W/m}^2\text{K}$
 - Cellar ceiling/base plate: $U_{\max} = 0.50 \text{ W/m}^2\text{K}$
- **Whole building renovation: 140%** of the primary energy requirement for new buildings

Energy Renovation in Germany: Renovation Rate

- dena (Germany Energy Agency) study:
 - ~ 50% of the 19 million residential buildings are up for renovation within the next 20 years
- ~ 1 million buildings per year in need of renovation
 - ~ 2.6% of the residential building stock
- Average renovation cycle of the building envelope: ~ 30 - 40 years
 - > opportunity to couple renovations with energy efficiency improvement has to be taken
- **Current renovation rate of the building envelope: ~ 1% per year**
- **Exchange rate of the heating system: ~ 3% per year**
- **Objective of the Energy Concept of the German Government: Doubling of the renovation rate: from 1% per year to 2% per year**

Energy Renovation in Germany: Additional Instruments



Energy Renovation in Germany: Financial Subsidies

- **KfW bank (state owned) offers the following financial subsidies:**
 - **Cheap loans:** 0.75%
 - Maximum 100.000 € / residential unit
 - Redemption subsidy up to 27.5%
 - **Investment subsidy:** up to 30.000 € (single-family house), 60.000 € (two residential units)
 - **Different programmes:**
 - Single measures: insulation of building envelope components, renewal of windows/doors, installation of mechanical ventilation, renewal of heating system, optimisation of heating systems
 - KfW Efficiency House 55 / 70 / 85 / 100 / 115 (= percentage of primary energy requirements for new buildings)
 - Subsidies grow with better energy performance
 - E.g. investment subsidies: 15% for KfW Efficiency House 115, 30% for KfW Efficiency House 55
 - **Combinations** with RES loans, construction site survey, listed buildings, adaption to elderly needs
- **Additional subsidies** for public buildings and retrofit manager of city districts

Energy Renovation in Germany: Financial Subsidies

- **Monitoring results** of KfW programmes Energy Efficient Retrofit in 2013:
(report of IWU and Fraunhofer IFAM)
 - **111,000 approved fundings for 276,000 residential units**
 - Applied measures:
 - Insulation of the building envelope: **as single measure: 55% of the buildings** / **within the KfW Efficiency Houses: 98% of the buildings**
 - New heating system: **> 50%** / **79%**
 - Solar thermal or PV: **18%** / **48%**
 - Mechanical ventilation systems (mostly with heat recovery): **6%** / **28%**
 - **Total savings** of all measures:

final energy:	1,745 GWh/year
primary energy:	2,500 GWh/year
CO ₂ eq. emissions:	650,000 t/year
heating costs:	~ 200 million €/year
 - **Investments: KfW: 3.9 billion €, total 6.5 billion €, 1 billion is VAT**
 - **Job creation: 79,000 person-years (80% craftsmen, 20% planners)**
 - **For 1 € the state gets back about 4 €:** VAT, less unemployment, more taxes

Energy Renovation in Germany: BAFA Market Stimulation Programme

- **Investment subsidies for renewable energy systems:**
 - Solar thermal systems
 - Biomass heating systems
 - Heat pumps
- **Investment subsidies for combined heat and power units (CHP)**
- Financial support for **energy saving consultancy**
- Can be **combined** with KfW promotion programmes

Energy Renovation in Germany: Research Initiatives / Demonstration Programmes

- **Building level: EnOB (Energy-Optimised Buildings)** www.enob.info
 - **Demonstration projects** for different building types with innovative technologies
 - Energy-efficiency requirements of the energy ordinance have to be topped by at least
 - 30% for non-residential buildings
 - 50% for residential buildings
 - Specific **focus on energy efficient schools** includes schools renovated to 3-liter-house level and even plus energy schools
 - New **technologies**: e.g. prefabricated façade modules for renovations
 - Optimisation of **building operation**



Energy Renovation in Germany: Research Initiatives / Demonstration Programmes

- **District level: EnEff:Stadt (Energy-Efficient Cities)** www.eneff-stadt.info
 - **Demonstration projects** for different types of city quarters
 - Energy-efficiency requirements: 30% less primary energy use than
 - Before for existing quarters
 - Energy performance requirements of energy ordinance for new quarters
 - Specific focus on **district heating and cooling** networks
 - New **technologies**: Organic rankine cycle (ORC), absorption cooling, alternative motor concepts for biogas, low-Ex-technologies
 - **Planning tools**: E.g. GIS-coupled tools, **District ECA**



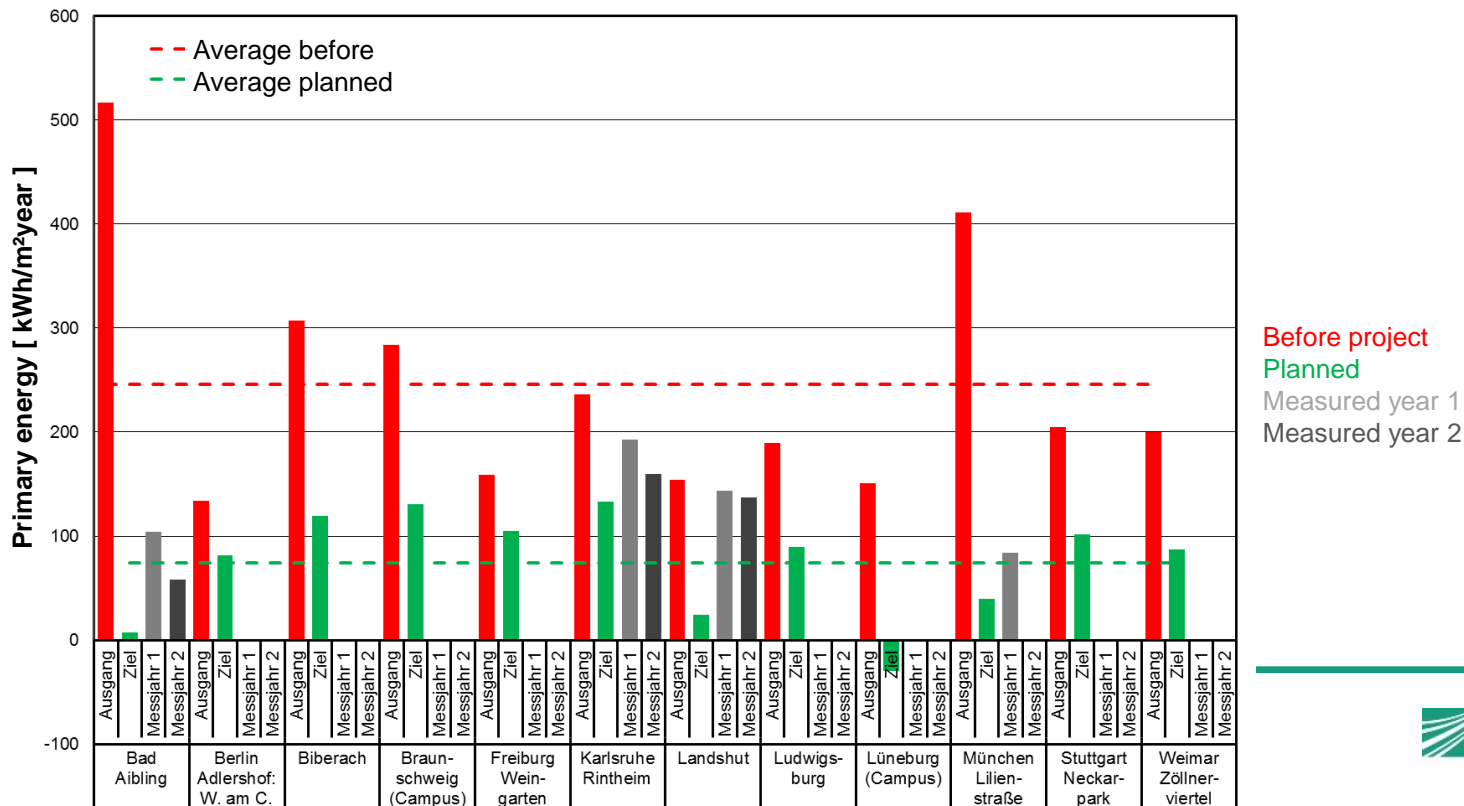
Energy Renovation in Germany: Research Initiatives / Demonstration Programmes

■ District level: EnEff:Stadt (Energy-Efficient Cities)

www.eneff-stadt.info

■ Accompanying research team analysing and comparing the demonstration projects

Primary energy of the city quarters



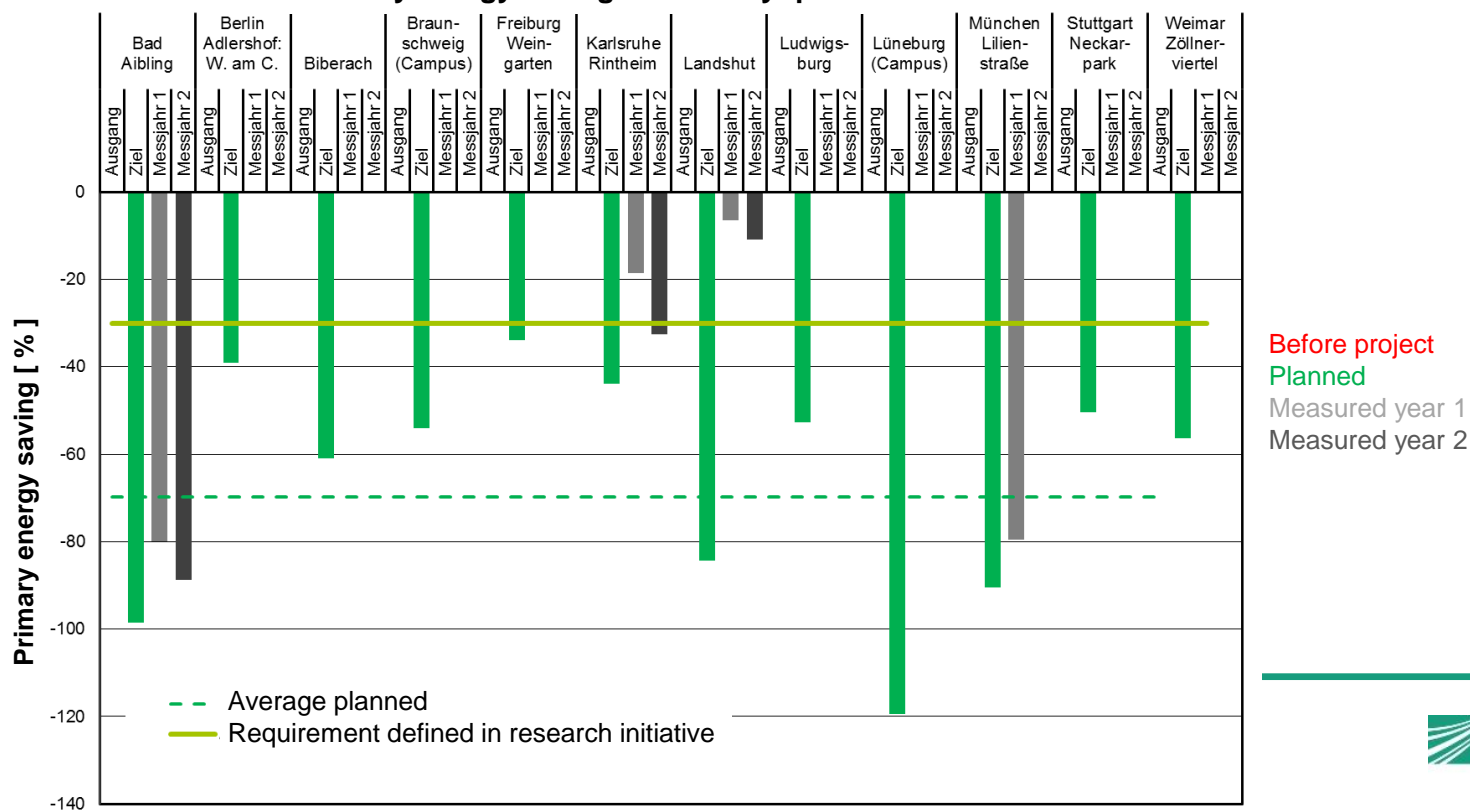
Energy Renovation in Germany: Research Initiatives / Demonstration Programmes

■ District level: EnEff:Stadt (Energy-Efficient Cities)

www.eneff-stadt.info

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Primary energy savings of the city quarters



Energy Renovation in Germany:

Regional legal requirements: RES integration



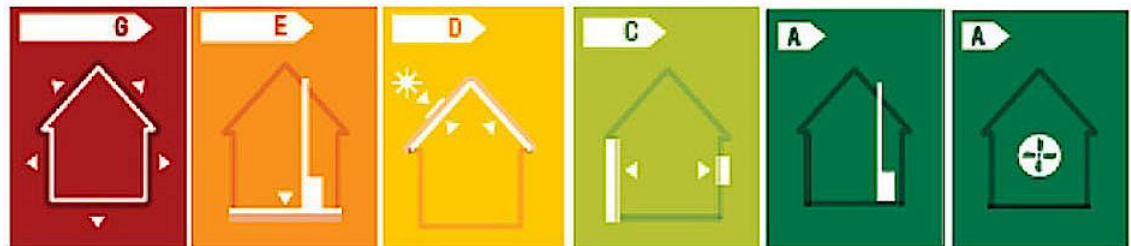
- Federal State of Baden-Württemberg launched a **regional requirement beyond the national requirement**
 - **National requirement EEWärmeG:**
 - **New buildings** have to partly use RES for heating (space heating + DHW): 15% solar thermal, 30% biomass, 50% geothermal or ambient energy
 - Specific combinations fulfilling the requirements given
e.g. solar thermal in SFH: 0.04 m² aperture area / living area
 - **Additional local requirement EEWärmeG Baden-Württemberg:**
 - If the **heating system is changed**, the heating (space heating + DHW) has to be covered by 15% with RES -> residential and non-residential buildings
 - Specific options to fulfill are listed
 - Replacement measures:
 - Increased insulation of building envelope
 - Combined heat and power (CHP), district heating, PV

Energy Renovation in Germany: Renovation Roadmap: A step-by-step procedure



- Replacement measure for local renovation requirement EEWärmeG Baden-Württemberg
 - Residential buildings: Can replace part of RES requirement (from 15% RES to 10% RES)
 - Non-residential buildings: Can replace 100% of RES requirement
- **Individual step-by-step renovation plan for a building**
- Currently no check concerning realisation of measures over time

SANIERUNGSFAHRPLAN



HEUTE

G

Jährliche Energiekosten

1.800 €

1.600 €

Jährliche CO₂-Emissionen

9.100 kg

Errechnet
Aktueller Verbrauch
(letzte 3 Jahre)

Sanierung in einem Zug

Sie können die Sanierung in einem Zug umsetzen. Dies erspart mehrfache Kosten für Baustelleneinrichtung, vereinfacht die Schnittstellen und Bauausführung und ermöglicht eine optimale Ausnutzung von Fördermitteln. Allerdings müssen einzelne Bauteile vor Ende der Lebensdauer erneuert werden. Sie erhalten dann eine Gesamtförderung von 24.000 Euro.

Schrittweise Sanierung

Sie können die Sanierung schrittweise in Maßnahmenpaketen durchführen. Hier schlagen wir Ihnen eine optimale Reihenfolge vor. Auf S. 4 und 5 lesen Sie, was Sie dabei beachten müssen.

1	E	Gas-Brennwertkessel mit Blogas-Anteil, Kleinmaßnahmen	Investition/davon für Energiesparmaßnahmen	15.000 €/9.500 €
			Förderung	1.500 €
			Empfohlener Zeitraum	2015-2018
2	D	Dachdämmung, Solaranlage, Kleinmaßnahmen	Investition/davon für Energiesparmaßnahmen	44.500 €/25.500 €
			Förderung	3.000 €
			Empfohlener Zeitraum	spätestens 2025
3	B	Wärmedämmung Außenwand, Fensteraustausch	Investition/davon für Energiesparmaßnahmen	30.500 €/18.500 €
			Förderung	2.780 €
			Empfohlener Zeitraum	Sobald umfangreiche Putz- erneuerung erforderlich
4	B	Holzpelletkessel (zweiter Heizungsaustausch)	Investition/davon für Energiesparmaßnahmen	19.000 €/12.500 €
			Förderung	5.750 €
			Empfohlener Zeitraum	Spätestens 2037 oder wenn Kessel defekt
5	A	Lüftung mit Wärmerückgewinnung	Investition/davon für Energiesparmaßnahmen	7.000 €/7.000 €
			Förderung	800 €
			Empfohlener Zeitraum	möglichst bald

A

Jährliche Energiekosten Ziel (ohne Energiepreisteigerung)

400 €

Jährliche Energiekosten Ziel (mit 3,5 % Energiepreisteigerung, 2030)

690 €

Jährliche CO₂-Emissionen (mit heutigem Strommix)

1.400 kg

Errechnet, in heutigen Preisen
Einsparung gegenüber heute

ZIEL

Step-by-step renovation: Example with investments, financial support, recommended period of time

Step 1: Gas condensing boiler with partly biogas

Step 2: Insulation of roof, solar thermal system

Step 3: Insulation of wall, window replacement

Step 4: Wood pellet boiler (exchange of gas condensing boiler)

Step 5: Ventilation system with heat recovery

Aim: annual energy costs without and with energy price increase (3.5%), annual CO₂ emissions

Energy Renovation in Germany: City of Stuttgart's retrofit standard including quality control

- City of Stuttgart has developed its **own retrofit standard** including the following steps offered by the city's energy consultancy office to ensure a **quality control**:
 - initial consultation for free
 - energy diagnosis
 - expert network with trained architects, engineers, craftsmen of different trades
 - information on possible funding programmes
 - construction supervision
 - energy performance certificate
 - training courses for professionals
 - information events for building owners
- City offers **investment subsidies** of up to 100 €/m² for energy renovation of buildings (can be coupled with KfW and BAFA)
- Information on quality control: IEE QUALICheck
www.qualicheck.eu

The District Energy Concept Adviser

INTERNATIONAL ENERGY AGENCY

Energy Conservation in
Buildings & Community
Systems Programme



IEA ECBCS Annex 51: Energy Efficient Communities

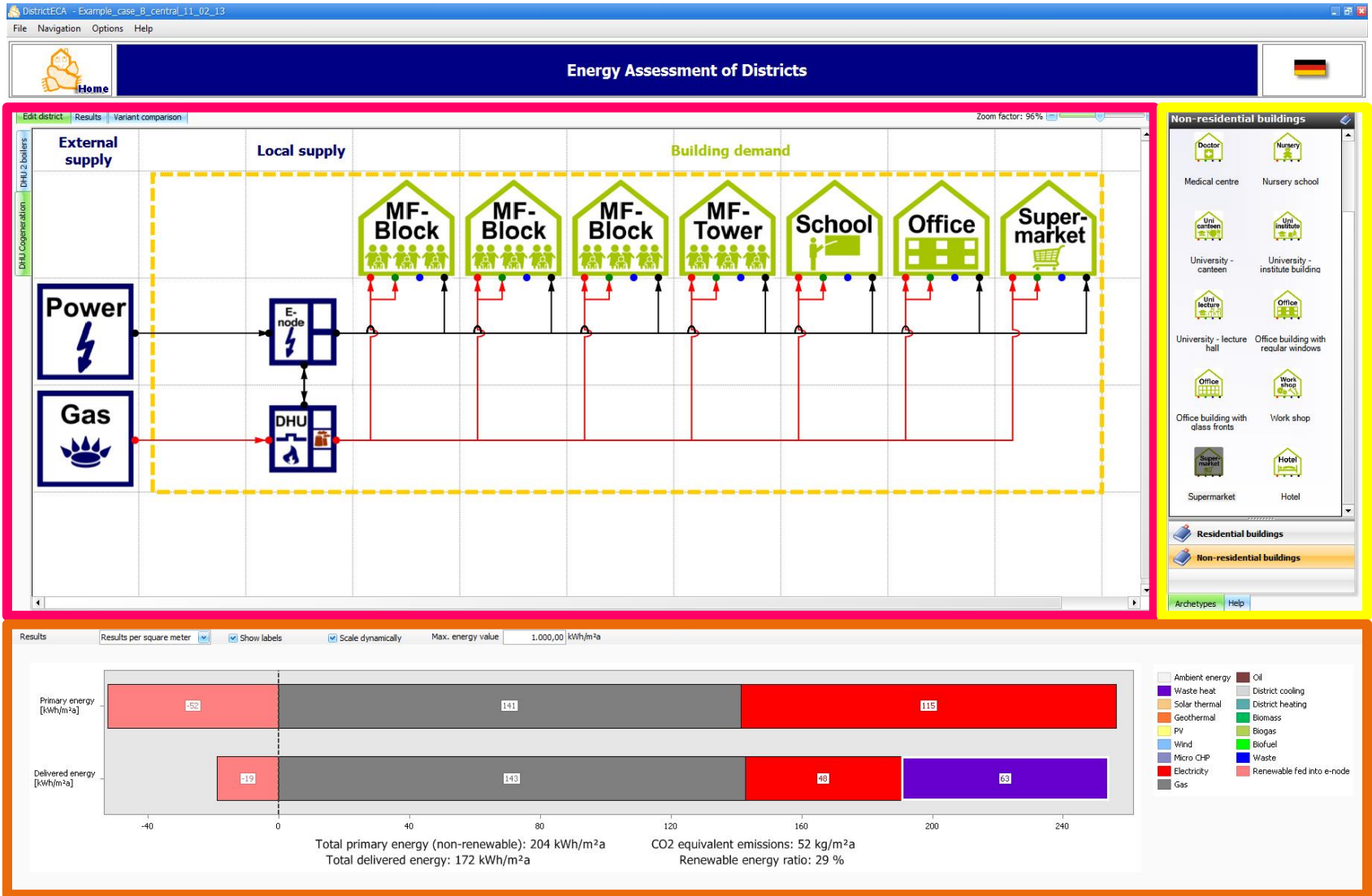
Case Studies and Strategic Guidance for Urban Decision Makers



District Energy Concept Adviser

Click on a flag to start the tool





DistricTECA - Example_case_B_central_11_02_13

FileNavigationOptionsHelp

General

U-/g-values

(1) Building information

Name

Archetype

File with detailed information

Year of construction/ insulation level

Net floor area

(2) Heating + hot water systems

Space heating system

Energy carrier of space heating

Hot water generation

(3) Solar water heating

Type of solar thermal system

Collector area

Collector orientation

Collector inclination

Office building

Constant-temperature

Low-temperature

Condensing boiler

No solar thermal system

Hot water heating

Solar supported heating

Delivered energy [kWh/m²a]

-40

0

-19

Energy

Total delivered energy

Delivered energy related to net floor area

(4) Ventilation

(5) Cooling system

Share of cooled area

(6) Electricity consumer

Lamps

(7) Renewable electricity generation

☒ PV system available

PV collector area

PV collector orientation

PV collector inclination

☐ Wind power generation available

Disk area

Hub height

Use of renewable electricity

50 %

Fluorescent lamps with elect. ballast

30,00 m²

South

15°

0,00 m²

0,00 m

Feed-in only

Self-consumption only

Priority self-consumption

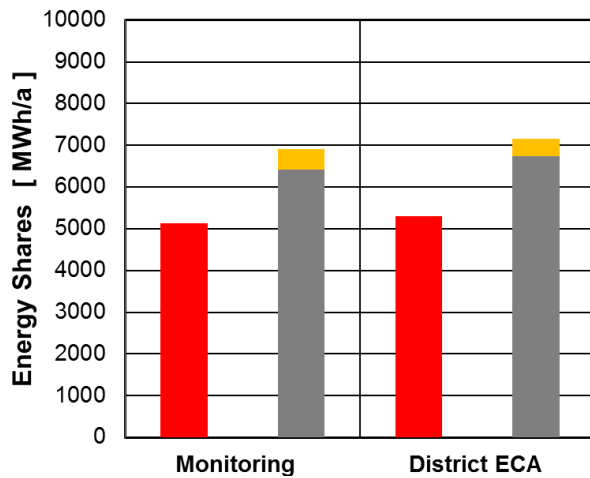
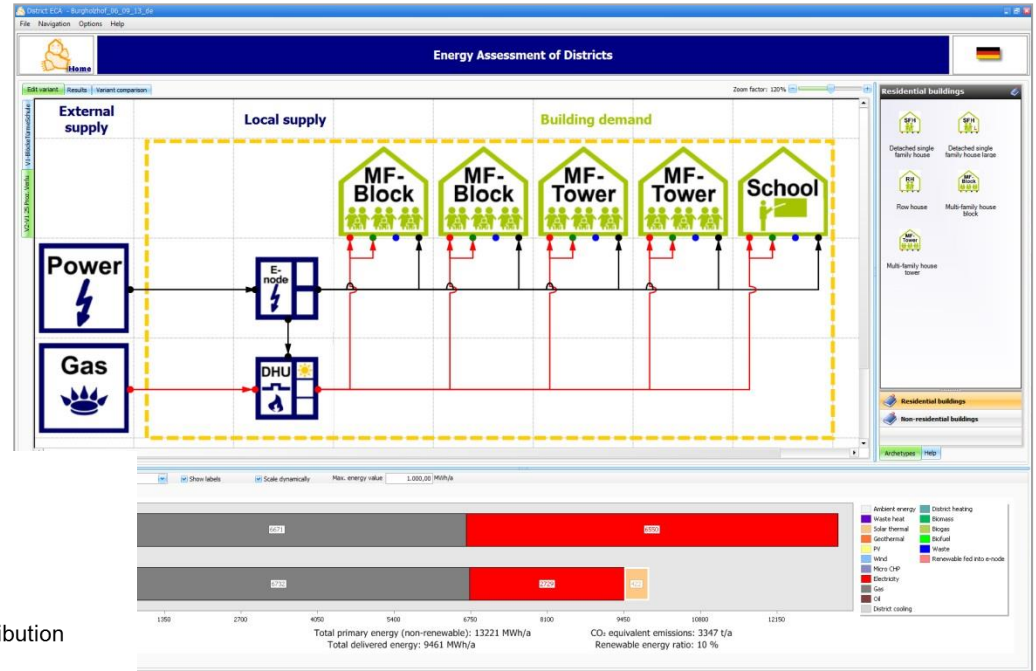
Optimized self-consumption

Feed-in only

er

IBP

Example of an assessment with the District ECA: Stuttgart-Burgholzhof



- Solar contribution
- Gas consumption
- Building energy use for heating and hot water

Present and future of the District Energy Concept Adviser

- Downloads:
 - 656 downloads of the international version
 - 1065 downloads of the national version „EnEff:Stadt Energy Concept-Berater für Stadtquartiere“
- Applied in the German BMWi research initiative EnEff:Stadt
 - Berlin Adlershof
 - Neckarpark Stuttgart
 - ...
- Applied for other energy concepts of neighbourhoods (KfW, community planners)
- Tested by the University of Wuppertal
- **Further development (costs, additional countries, additional technologies) within EU MODER: cooperation with Sweco and VTT**

Download www.district-eca.com

Focus on Apartment Buildings with multiple Ownership



- EU IEE project LEAF: Low Energy Apartment Futures
- **Buildings with multiple ownership have a low renovation rate**
- Project offers:
 - Case studies
 - Motivation toolkit in 6 languages
 - Technical toolkit in 6 languages
 - What is an energy performance certificate?
 - Recommended measures -> investment cost database, payback
 - User behaviour influence on energy use
 - Other energy saving opportunities: lighting, elevators, household equipment, common lighting (stairways, external lighting)

Energy Performance Assessment Procedure for the Building Stock of the Federal State of Baden-Württemberg



- Building stock is very diverse: office buildings, schools, theatres, police stations, jails, courts, town halls etc.
- **Structured process for:**
 - Building inspection and data acquisition
 - Energy assessment
 - Development of energy saving measures
 - Documentation
 - Tools, checklists etc. -> building profile
 - Each building is assessed by a consultant according to the procedure